

CFSv2 Assessment

Arun Kumar

Climate Prediction Center

Outline

- **CFSv2 hindcasts and real-time forecast configuration**
- **Application of the CFSv2 forecasts**
- **Skill assessment**
 - *Extended-range*
 - *Seasonal*
 - *Summary*
- **Model Bias**
- **Some lessons, requirements and issues**

Climate Forecast System Version 2

- **Implemented April, 2011 – Climate Forecast System version 2 (CFSv2)**
- **Old system**
 - ***Climate Forecast System version 1 (CFSv1) – implemented September, 2004***
 - ***Currently running in parallel (until 31st October, 2012)***

CFS Version 1 vs. Version 2

	CFSv1	CFSv2
Atmosphere	GFS 2003 (T62/L64)	GFS2009 (T126/L64)
Land	OSU 2-L	NOAH 4-L
Ocean	MOM3	MOM4
Sea ice	Climatology	Predicted
CO₂	Fixed at 1988 level	Observed Estimate
Initial conditions	R2 & GODAS	CFSR
Hindcast (seasonal)	15/month (5 every 10th day); 1982-2008	~24/month (4 runs / 5 days); 1982-2010
Hindcast (monthly)	-	4 runs/day; 1999-2010
Forecast	4 runs/day	4 runs/day (seasonal) 16 runs/day (45 days)

4

Outline

- CFSv2 hindcasts and real-time forecast configuration
- Application of the CFSv2 forecasts
- Skill assessment
 - *Extended-range*
 - *Seasonal*
 - *Summary*
- Model Bias
- Some lessons, requirements and issues

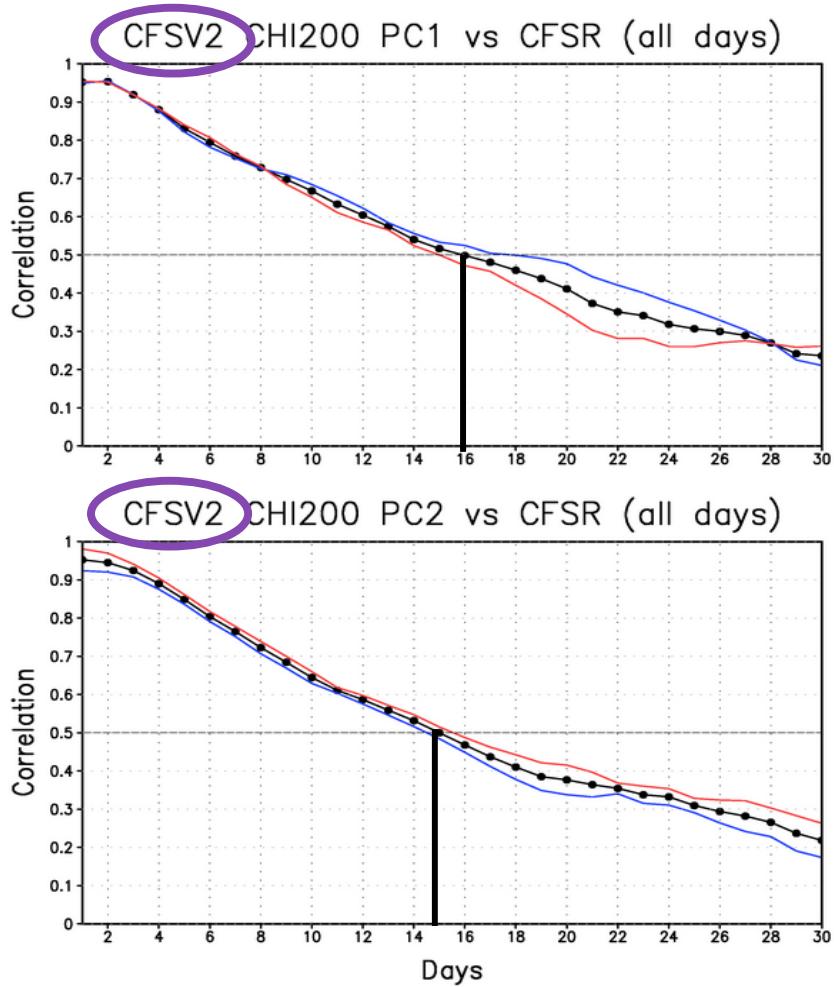
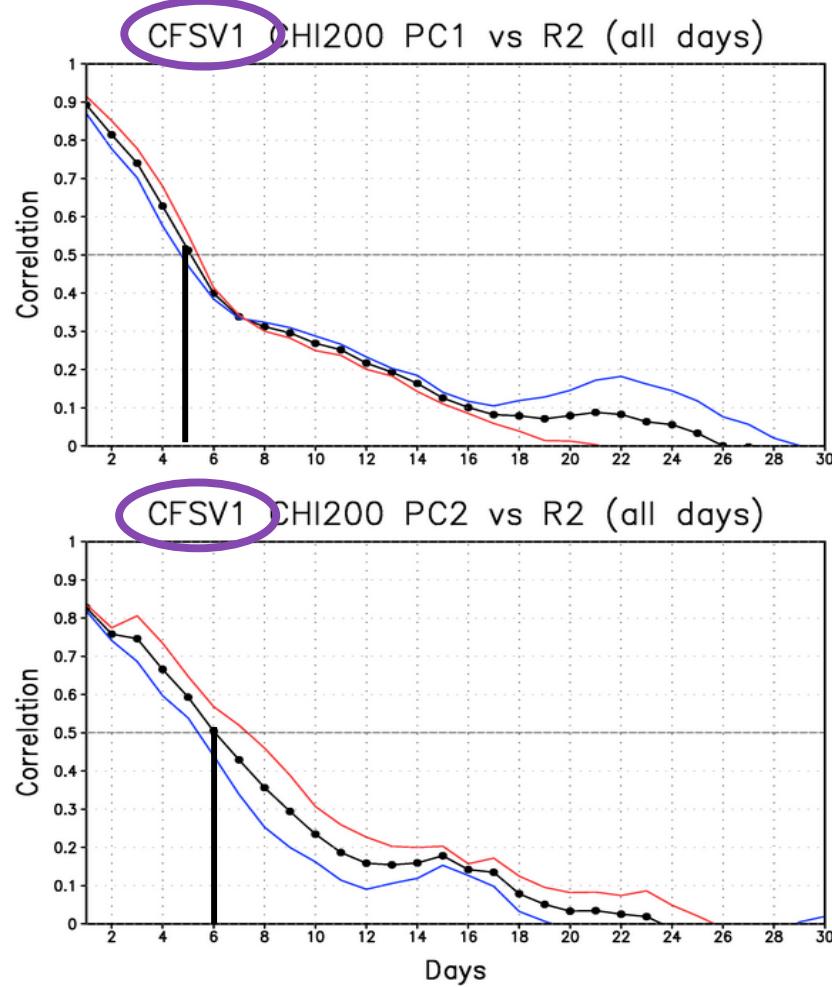
Applications of the CFSv2

- CPC's operational week1 and week2 forecast over the US; Global Tropical Hazard; MJO
 - *Based on 16 forecasts/day to 45 days*
- CPC's operational monthly forecast over the US; MJO
 - *Based on 16 forecasts/day to 45 days*
- CPC's operational seasonal forecast over the US
 - *Based on 4 forecasts/day ; lagged ensemble*

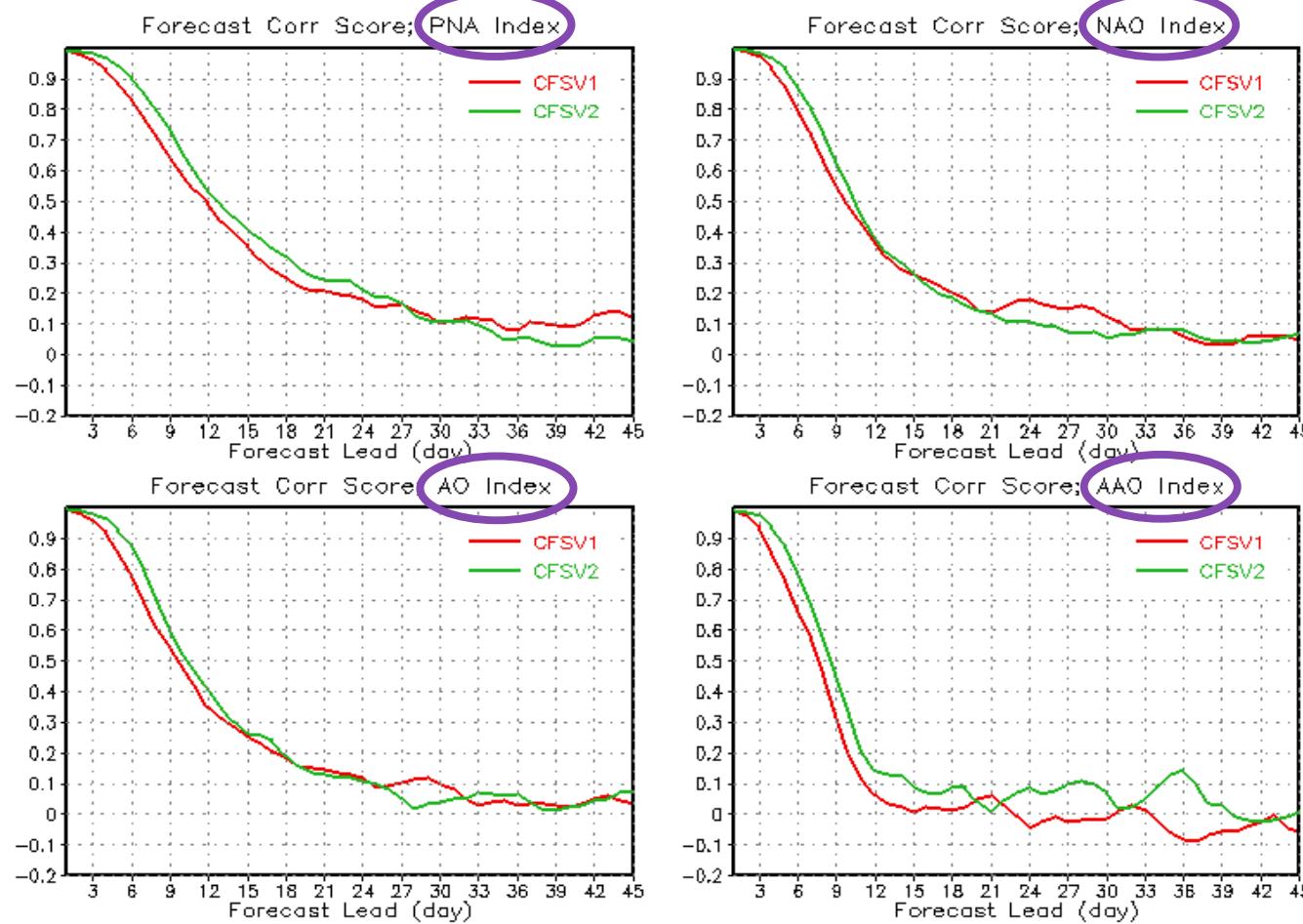
Outline

- CFSv2 hindcasts and real-time forecast configuration
- Application of the CFSv2 forecasts
- Skill assessment
 - *Extended-range*
 - *Seasonal*
 - *Summary*
- Model bias
- Some lessons, requirements and issues

Assessment of MJO Prediction Skill



Anomaly Correlation for Atmospheric Indices



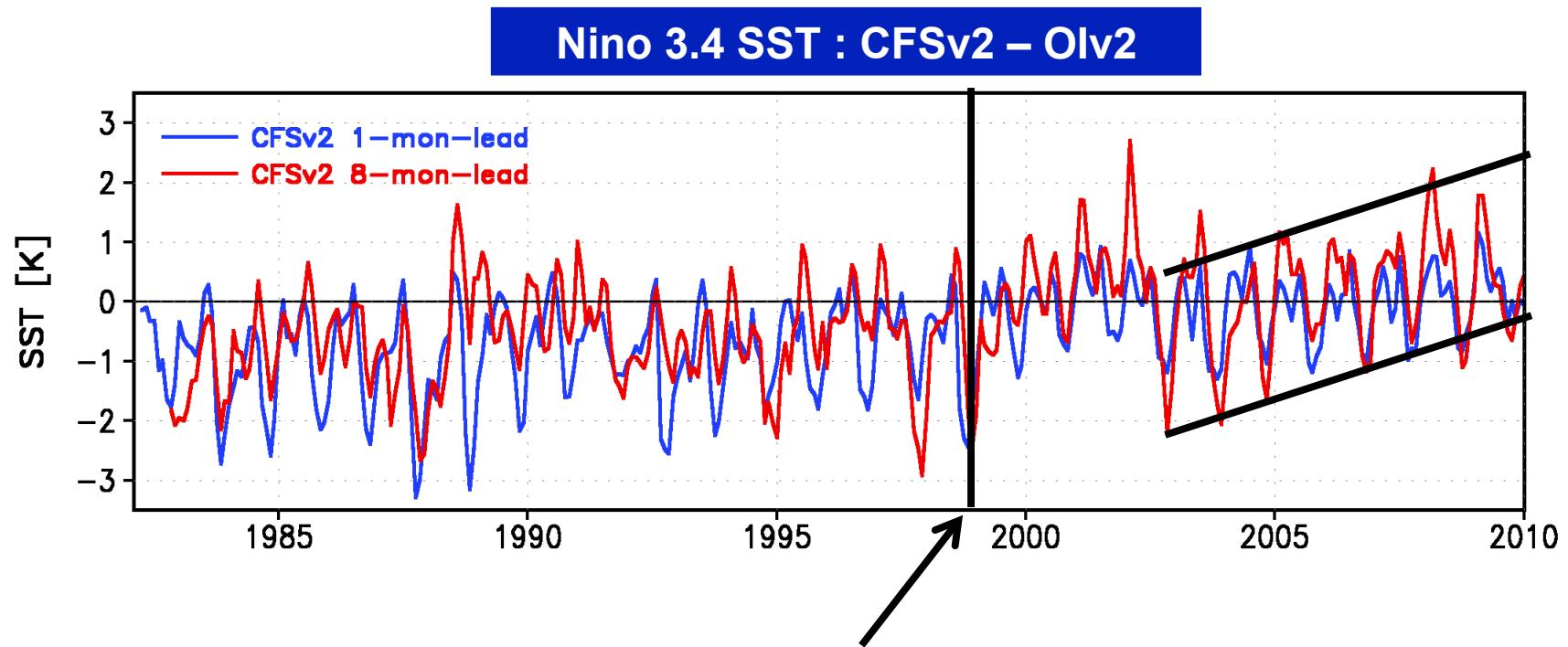
J. Schemm CPC/NCEP

Outline

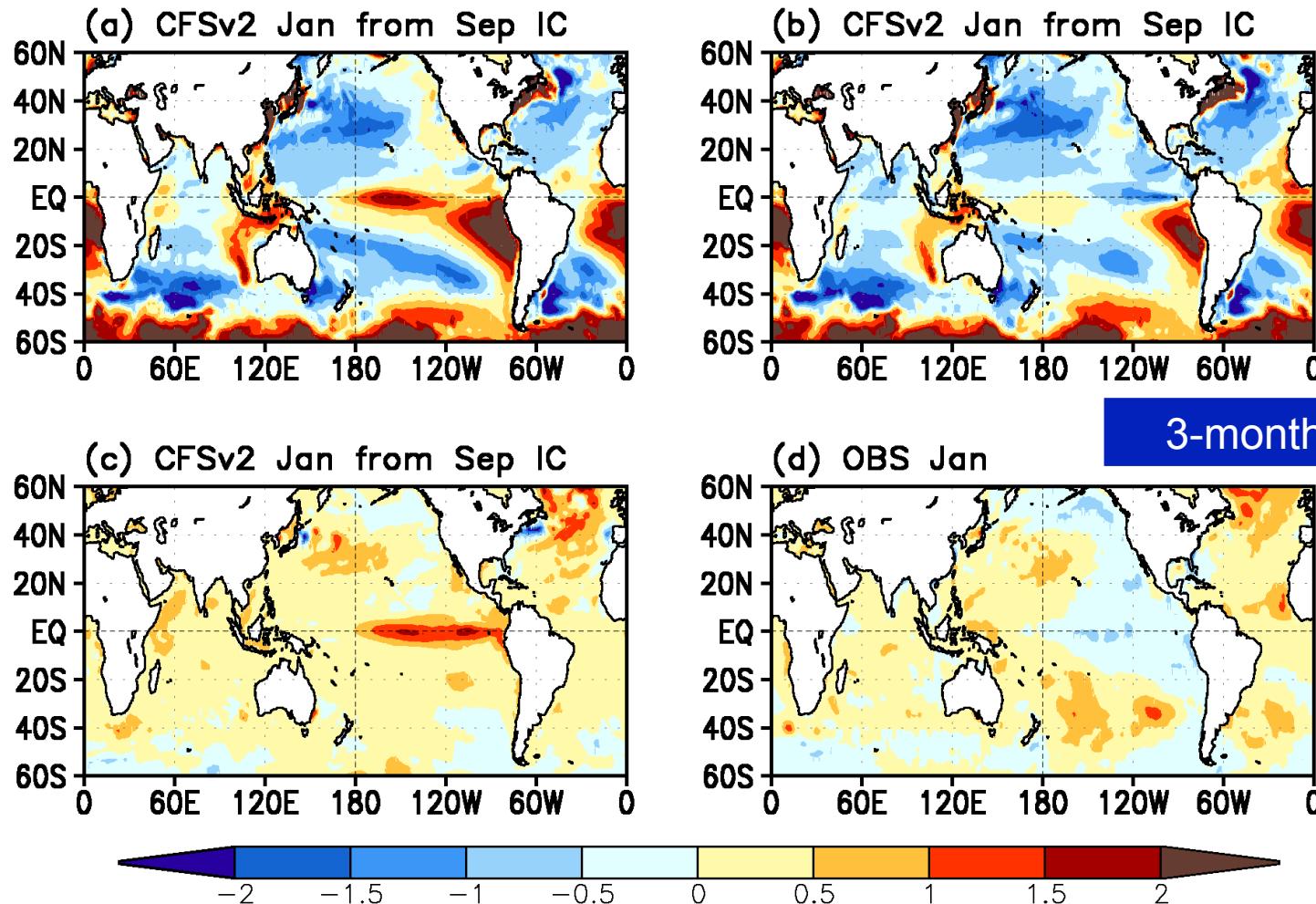
- CFSv2 hindcasts and real-time forecast configuration
- Application of the CFSv2 forecasts
- Skill assessment
 - *Extended-range*
 - *Seasonal*
 - *Summary*
- Model bias
- Some lessons, requirements and issues

Some Background

A Distinct Change in Forecast Bias for SST in Equatorial Pacific Before and After 1999



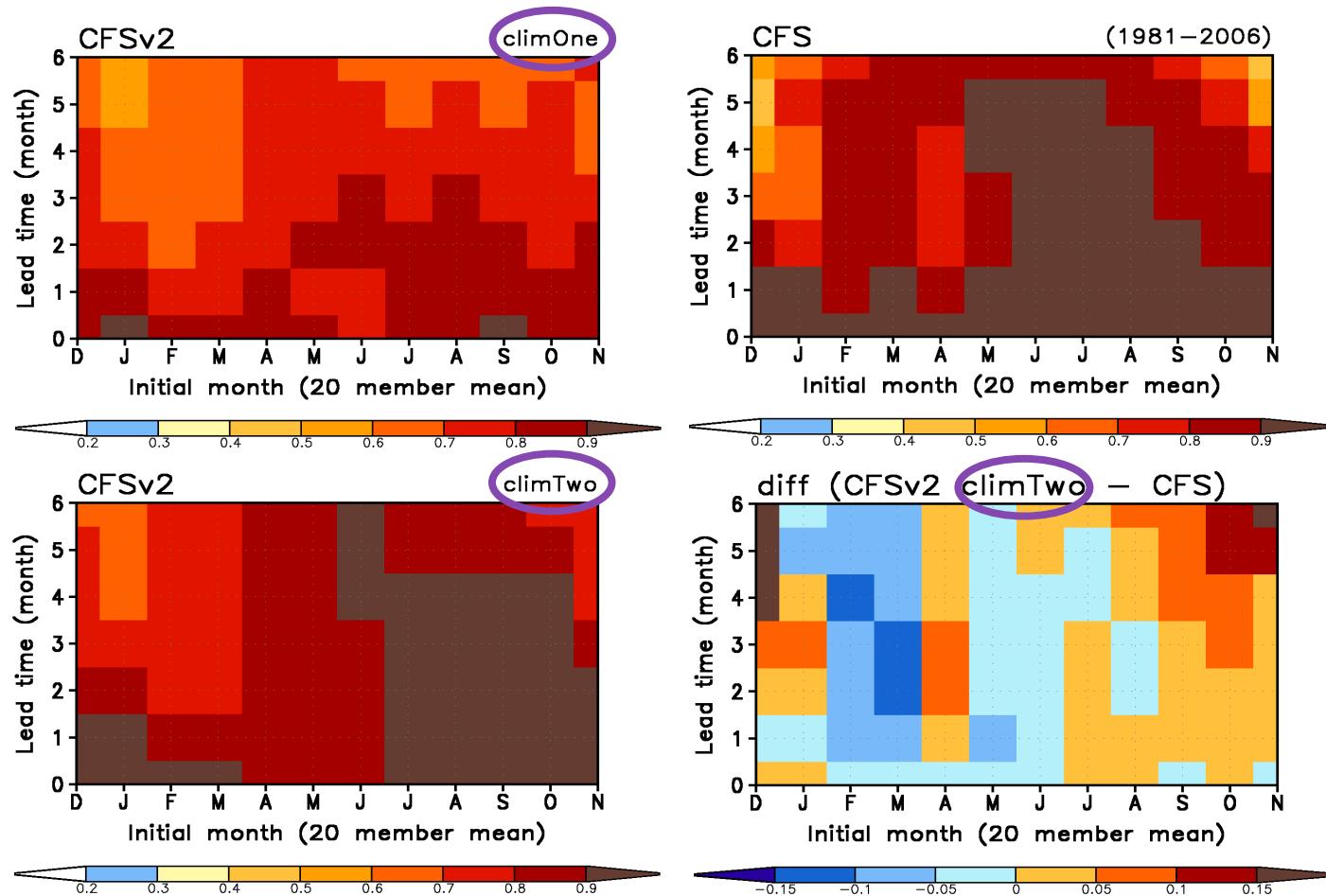
A Distinct Change in Forecast Bias for SST in Equatorial Pacific Before and After 1999



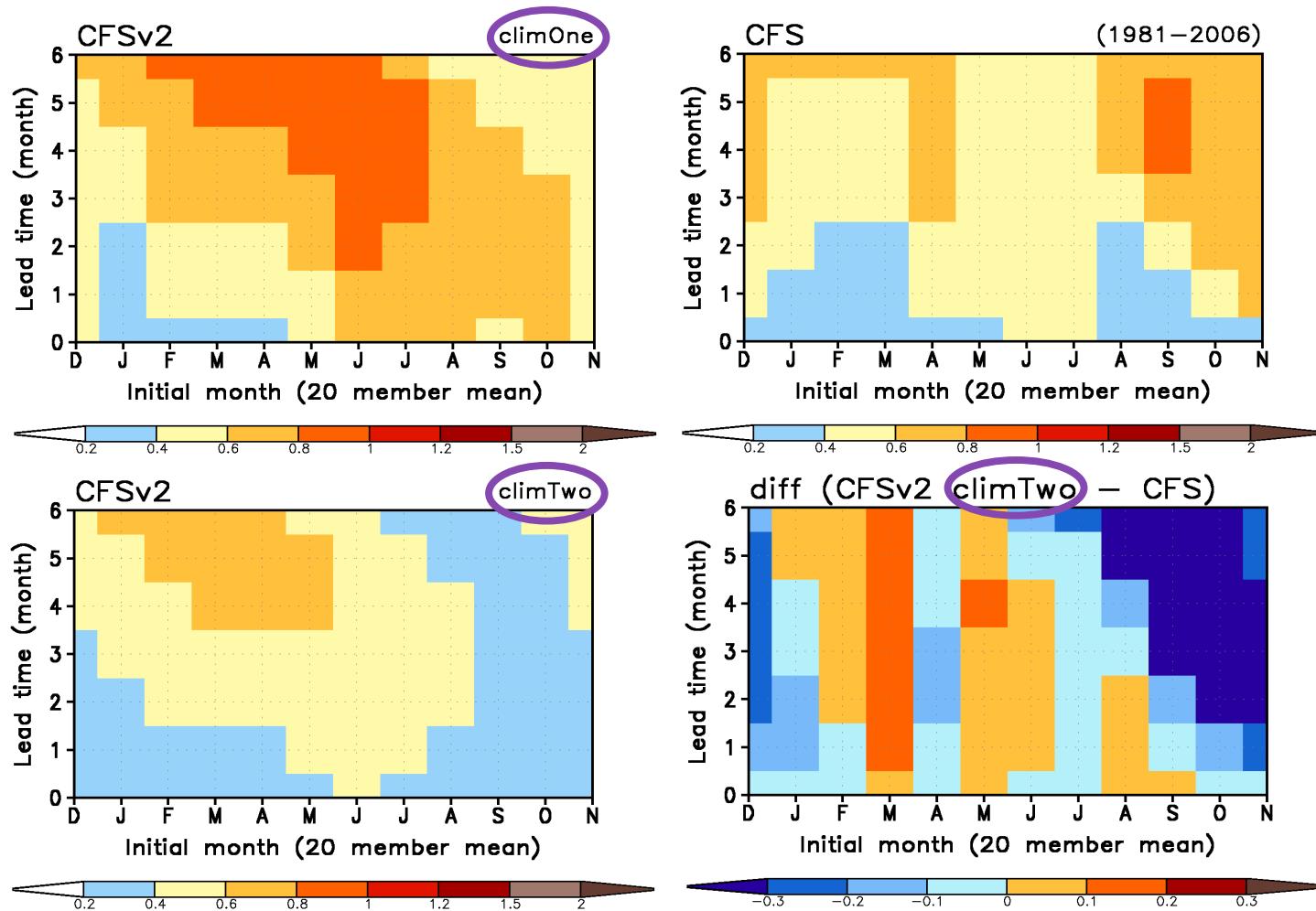
Seasonal Forecast and Verifying Data

- **Forecast members**
 - ***CFSv2 20 members***
 - ***CFSv1 15 members***
- **Reforecast period**
 - ***CFSv2 1982-2009***
 - ***CFSv1 1981-2006***
- **Climatology**
 - ***CFSv2 climOne, 1982-2009***
 - ***CFSv2 climTwo, 1982-1998, 1999-2009***
 - ***CFSv1 1981-2006***
- **Variables: SST, T2m, Precipitation**
- **Observations**
 - ***OI SST***
 - ***CAMS surface temperature: GHCN-CAMS***
 - ***CAMS-OPI rainfall***

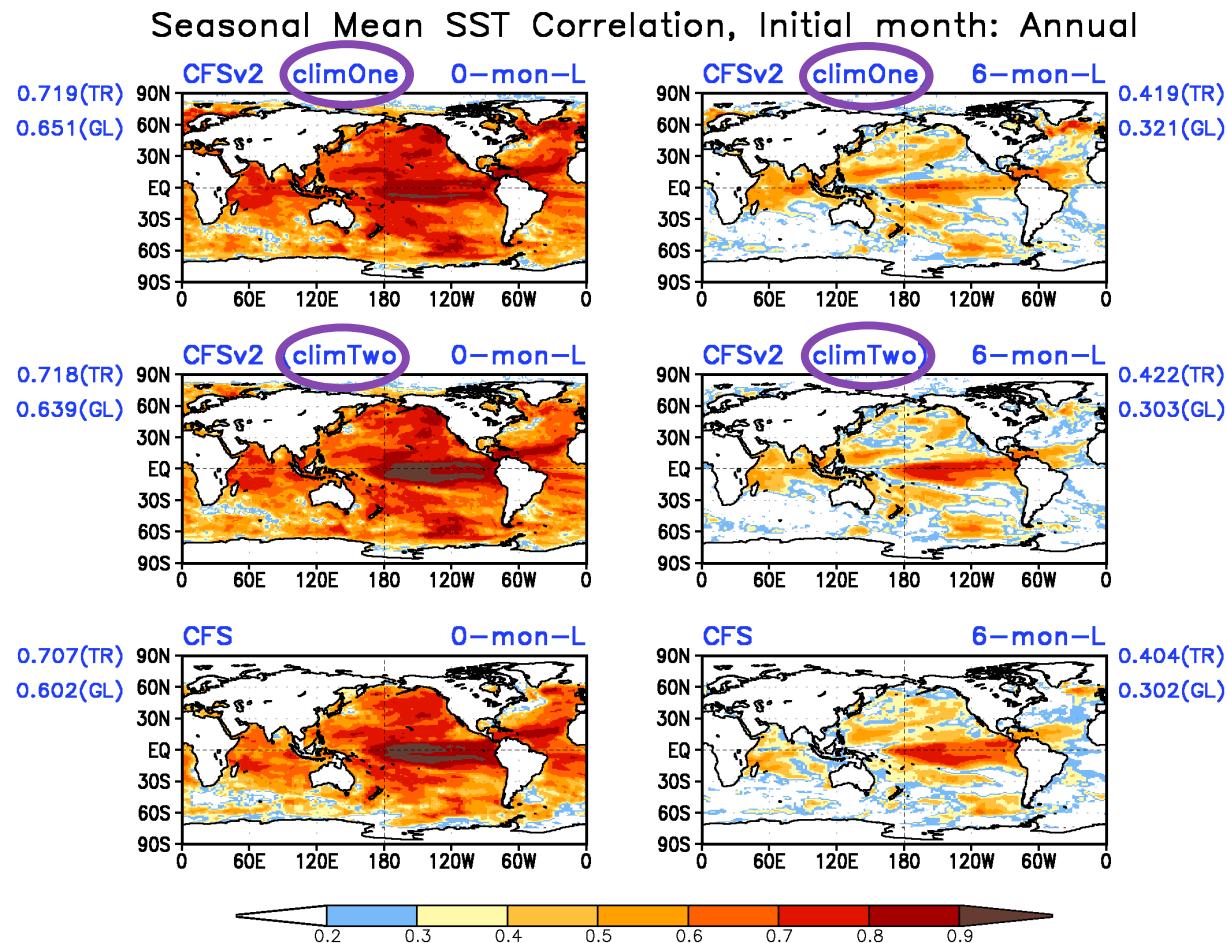
Anomaly Correlation for the Niño3.4 SST Index



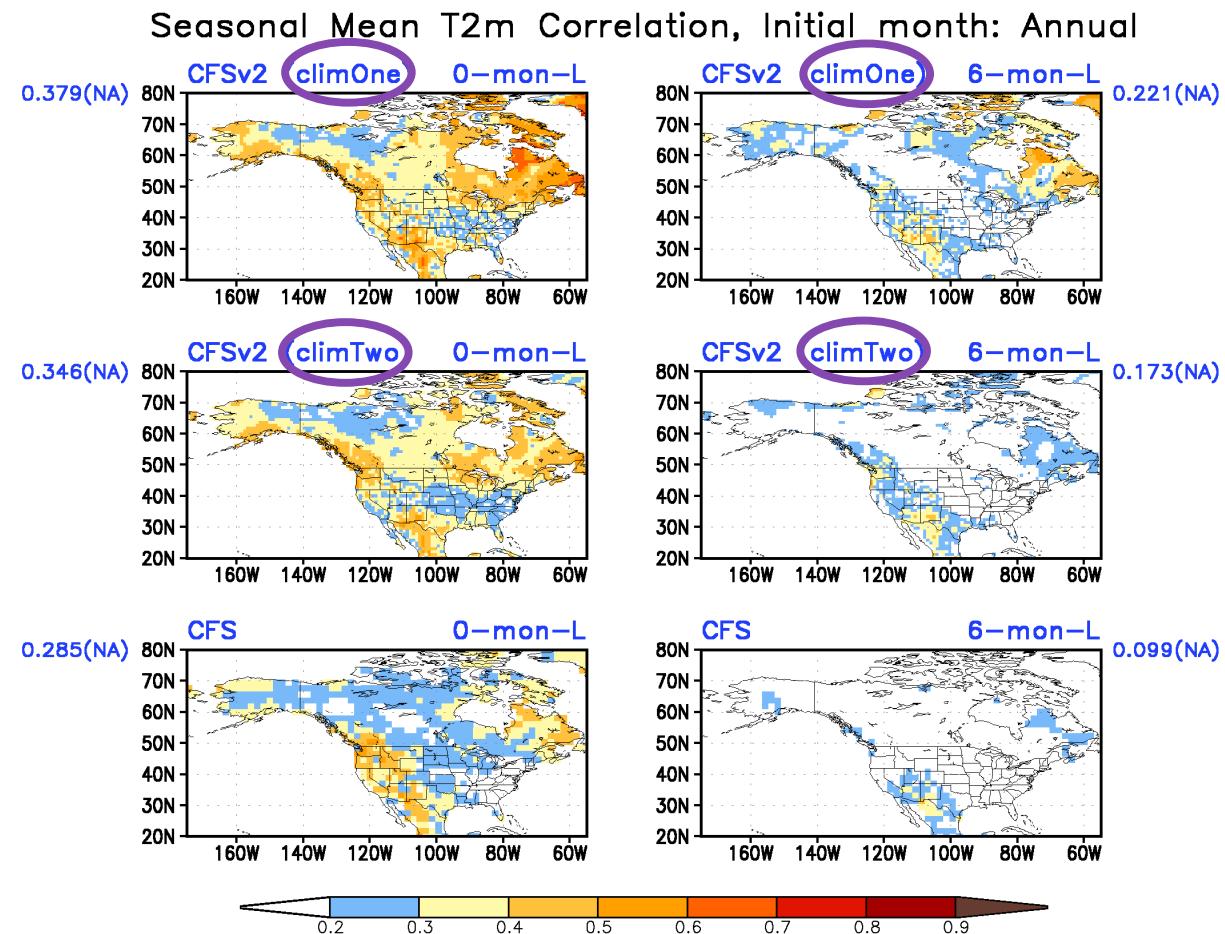
RMSE for the Niño3.4 SST Index



Anomaly Correlation – SST

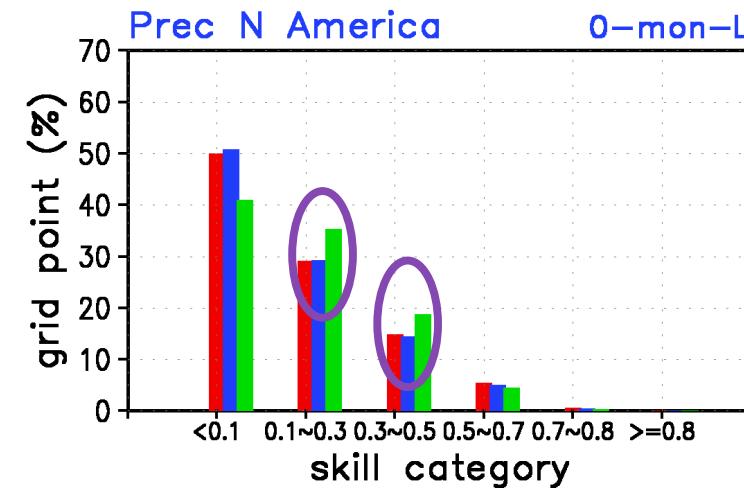
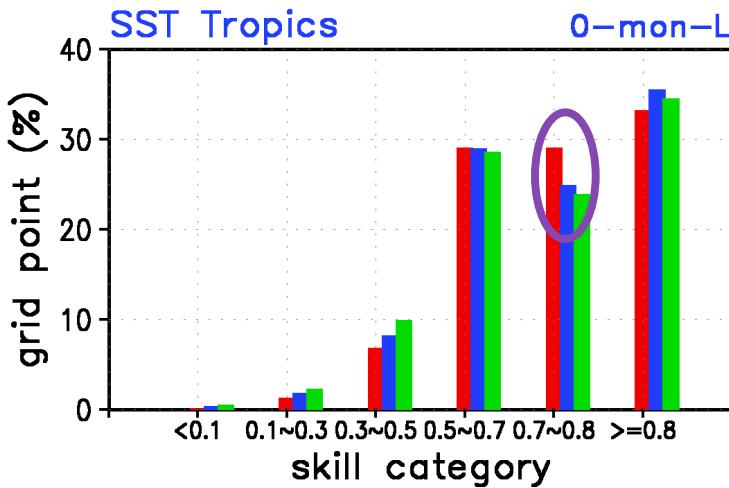
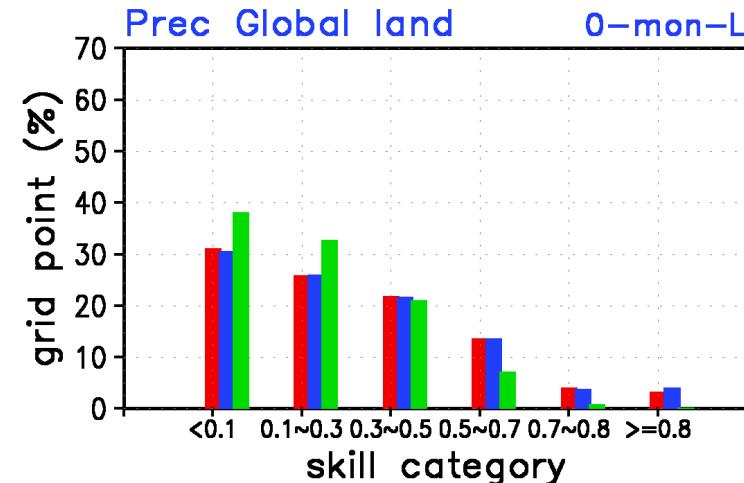
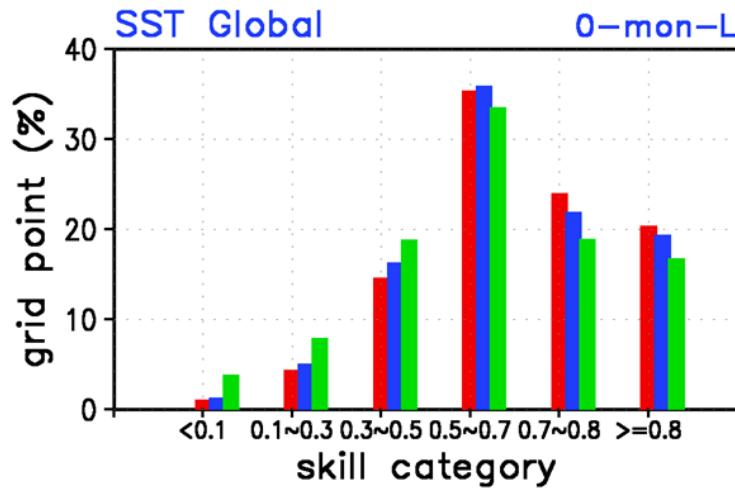


Anomaly Correlation – Sfc. Temp.

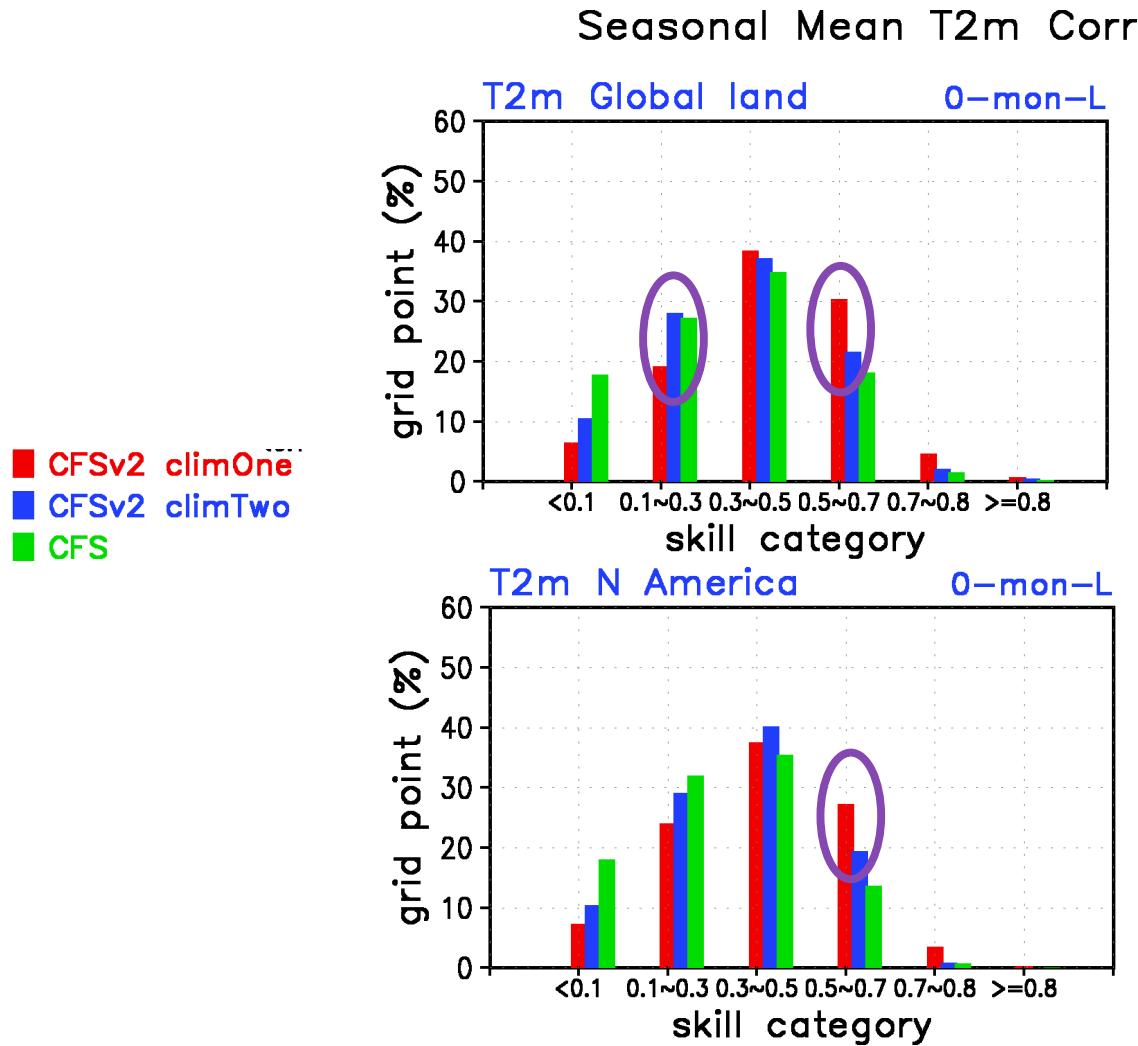


Skill: A Summary

█ CFSv2 climOne
█ CFSv2 climTwo
█ CFS



Skill: A Summary



Summary of Skill Assessment

- Clear improvements in the skill of extended-range predictions;
- For seasonal predictions
 - *Surface temperature forecasts have clear improvements due to time-varying CO₂*
 - *Not much change in the skill of precipitation forecast*
 - *SST forecast in extratropical oceans is better; in tropics similar for AC; better for RMSE*
- Change in forecast bias is something users have to be aware of.

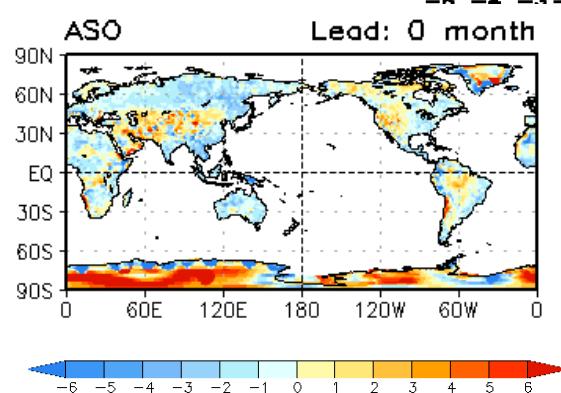
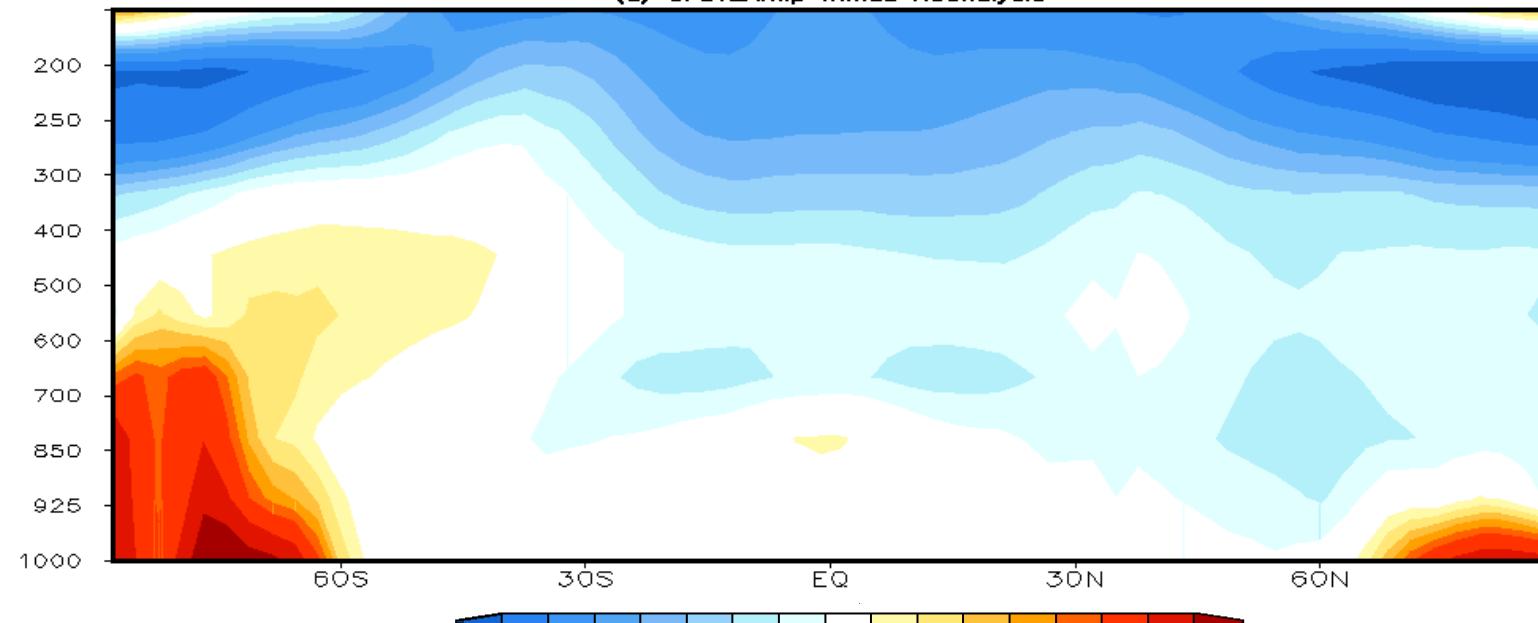
Outline

- CFSv2 hindcasts and real-time forecast configuration
- Application of the CFSv2 forecasts
- Skill assessment
 - *Extended-range*
 - *Seasonal*
 - *Summary*
- Model Bias
- Some lessons, requirements and issues

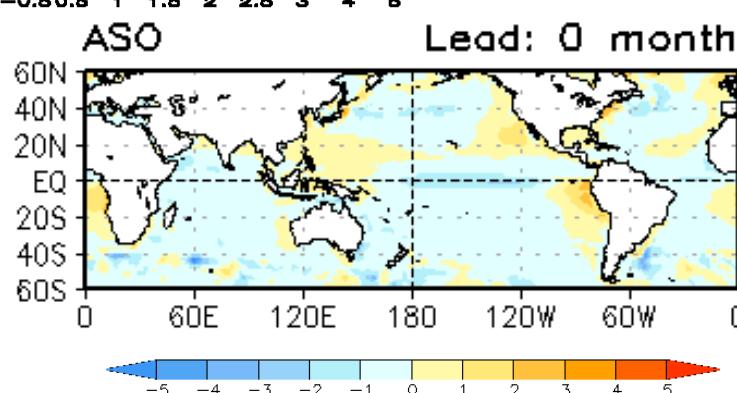
Zonal Mean T

CFSv2 Bias

Pressure Latitude distribution of zonal mean Temp annual mean(1979–2009)
(a) CFSv2Amp minus Reanalysis

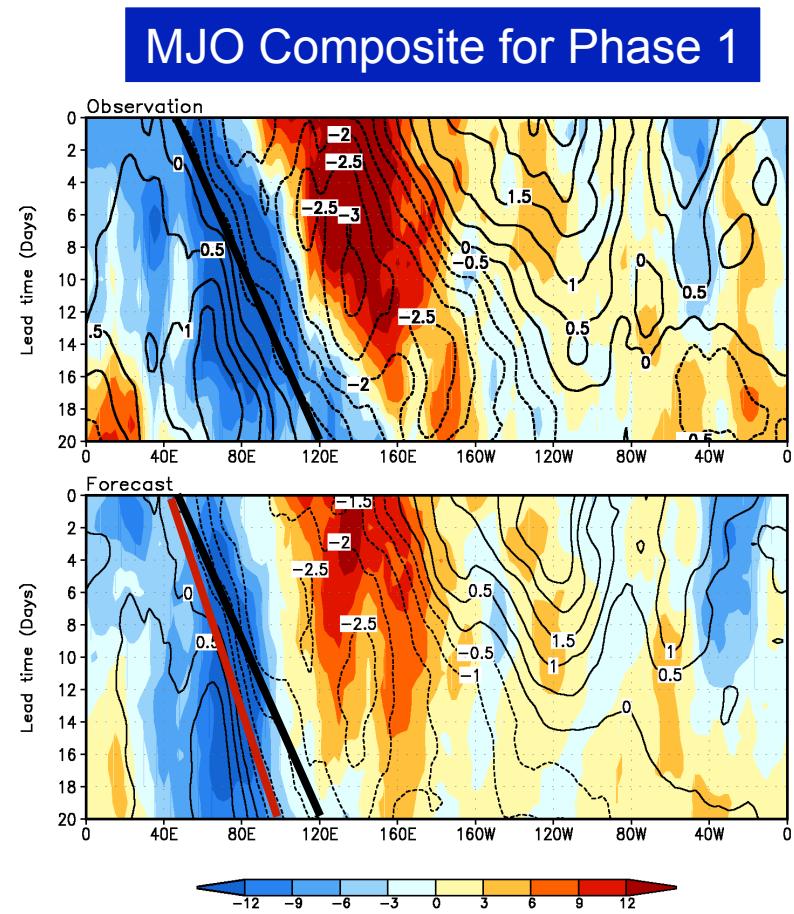
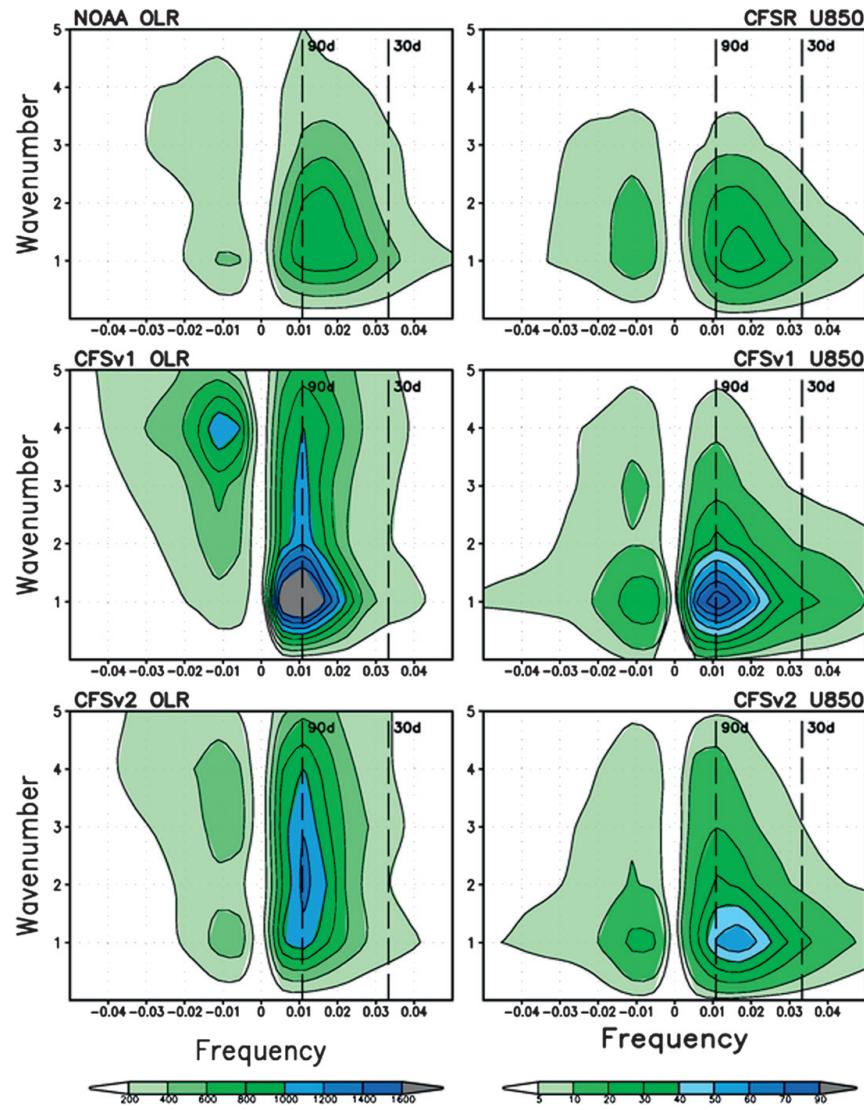


Land Temp.

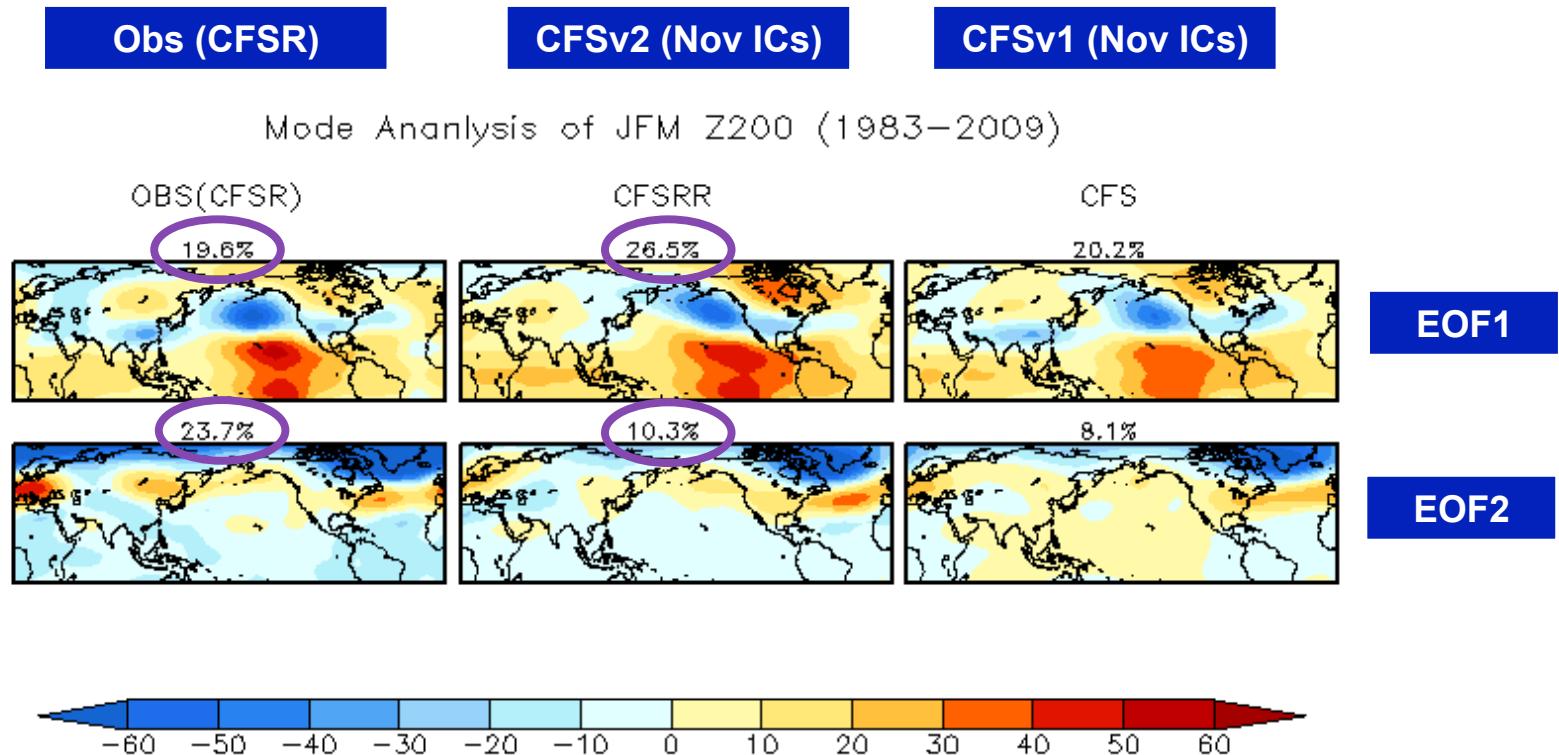


SST

CFSv2 Bias



CFSv2 Bias



Outline

- CFSv2 hindcasts and real-time forecast configuration
- Application of the CFSv2 forecasts
- Skill assessment
 - *Extended-range*
 - *Seasonal*
 - *Summary*
- Model Bias
- Some lessons, requirements and issues

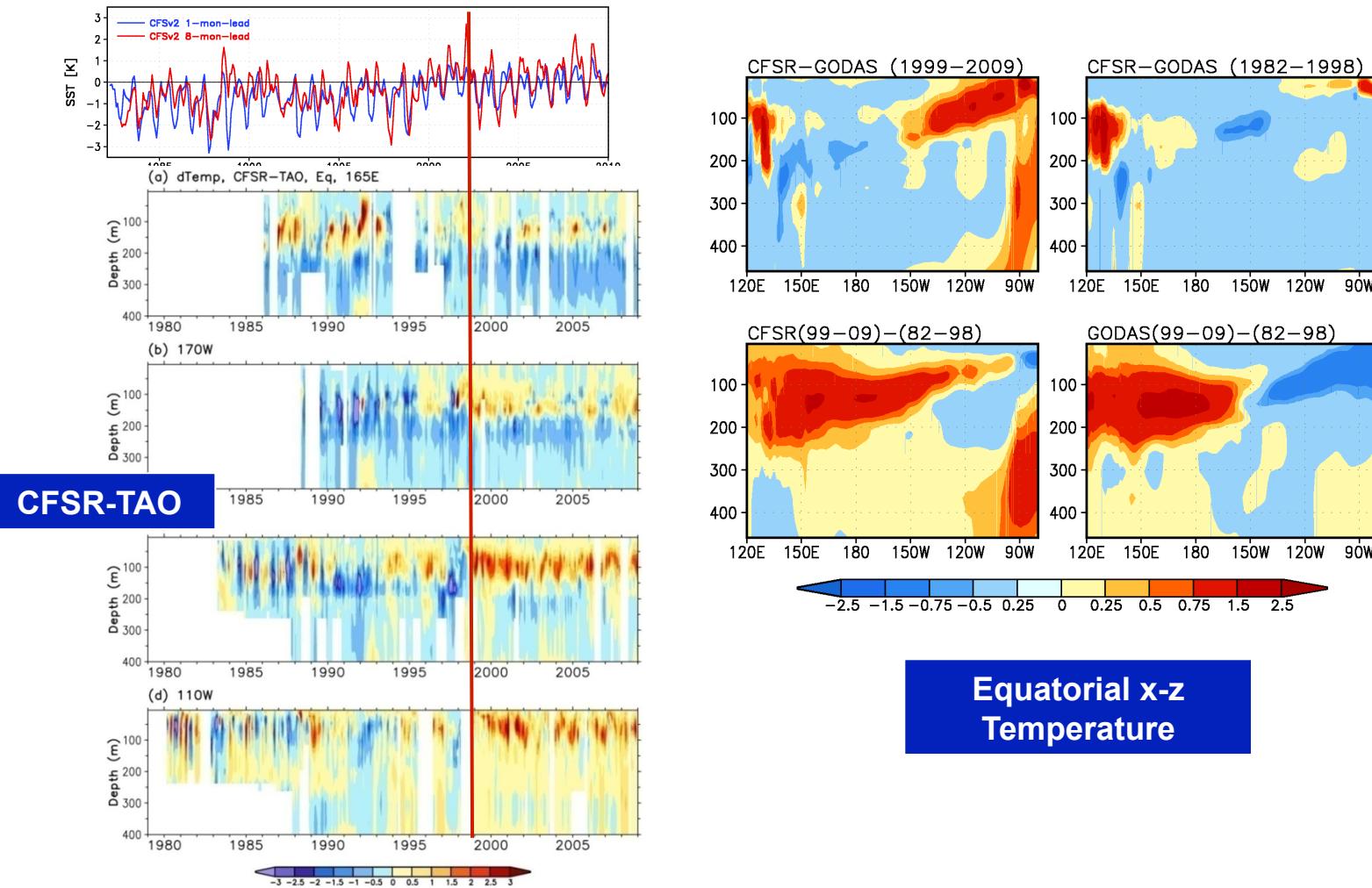
Lessons Learned and Some Thoughts

- Upgrades to seasonal prediction system are different from the upgrades in weather prediction models;
- Long-range predictions require “hindcasts” for the computation of real-time anomalies; and
- If downstream application models are involved then
 - *necessary hindcast data needs to be distributed;*
 - *users need to access the hindcast data, calibrate their application models, and gain familiarity with the nuances of the prediction system;*
 - *And all this requires a fair amount of lead time.*

Constraints, and Requirements for Long-Range Prediction Systems

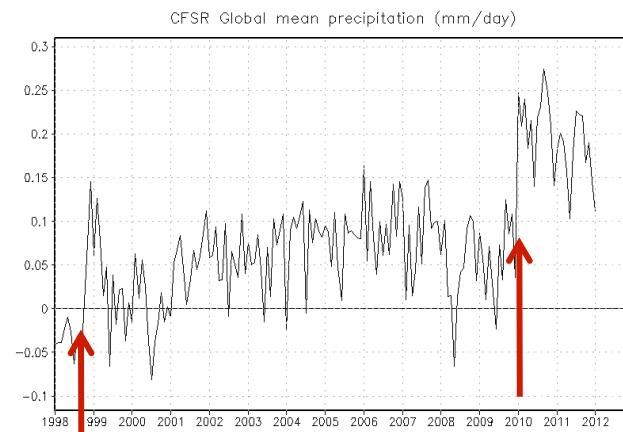
- **Because hindcasts provide the climatology relative to which real-time forecast anomalies are computed...**
- **There is a tight link between hindcasts and real-time forecasts;**
- **Changes in analysis from where initial conditions for hindcasts and real-time forecasts are drawn, need to be assessed carefully;**
- **Particularly for the slowly varying components of the Earth system (e.g., ocean, land, etc.), changes in which that can persist during the forecasts, and can show up as spurious anomalies.**

An Example for the CFSv2

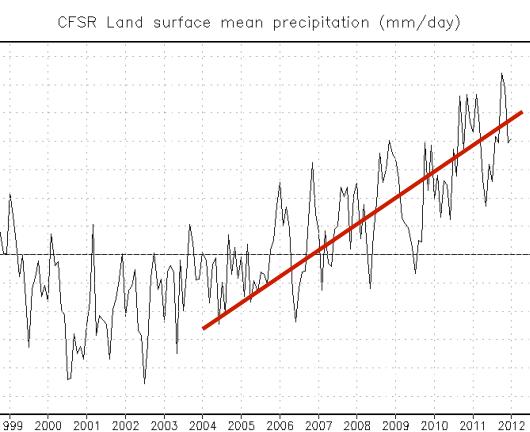


Some Recent Trends in the CFSR: Precipitation

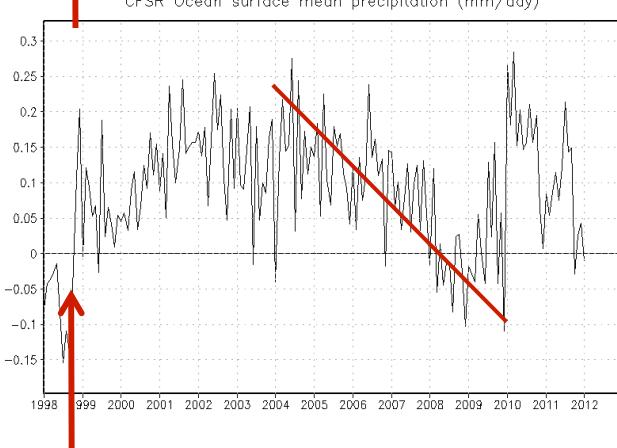
Global



Land



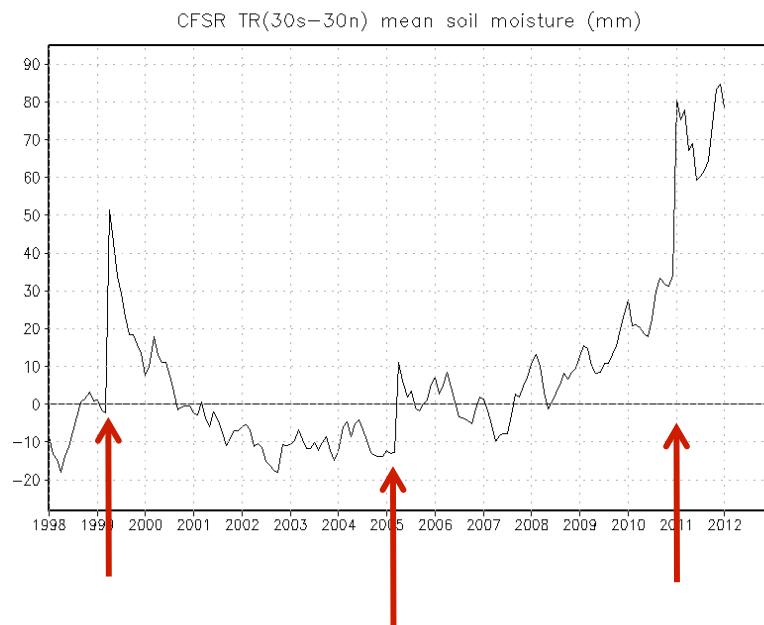
Ocean



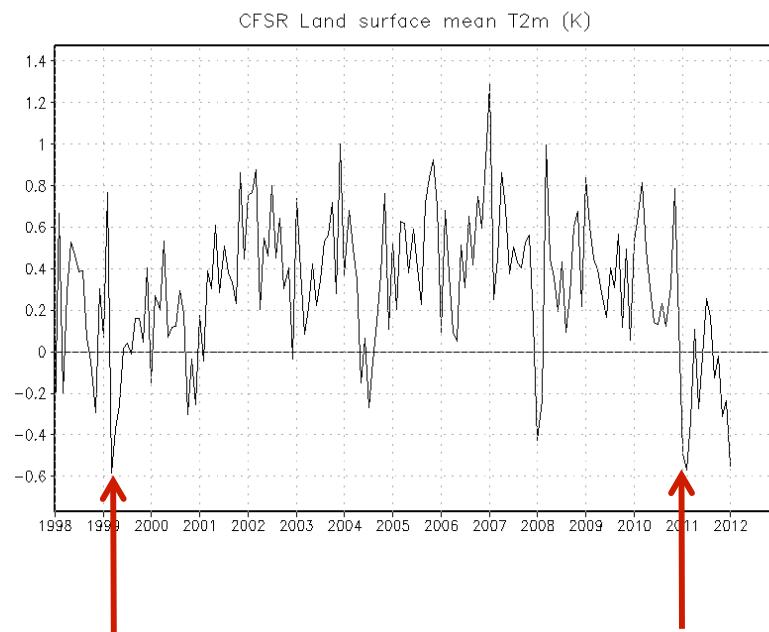
Some change in the CFSR
assimilation system ~ 2010!
GSI?

Some Recent trends in the CFSR

SM – Tropical



T2m – Global



Change in 2011 related to
change in the resolution
(T384 → T574)?

Influence of Recent Changes?

- Are changes in the real-time CFSR having an influence on the real-time seasonal forecasts (for which anomalies are computed relative to either 1982-2010 or 1999-2010 hindcasts)?
- This happened for the CFSv2 forecasts ~ 1999; Have seen similar issues in CFSv1;
- Not sure, but need to keeping an eye on monthly & seasonal forecasts.

A Wish List for the CFSv3

- **A careful assessment of slowly varying boundary conditions prior to initiating hindcasts;**
- **Assessment of model bias based on AMIP and CMIP simulations prior to initiating hindcasts (or reanalysis);**
- **For systems for which real-time predictions are tied with the hindcasts, influence of changes in the analysis (and analysis systems) need to be carefully evaluated.**

...there is no better substitute for validating models than confronting them with the observational data...and assessing predictions is one such way...

Thanks!

Backup Slides

CFSv2 Real-time Forecast Configuration

- Coupled model
 - **T126/L64**
 - **MOM4**
 - **MOM4- Sea-ice**
- **Seasonal:** 4 runs/day; 9-month predictions
- **Monthly:** 16 runs/day; 45-day predictions
- Initial conditions for the ocean, atmosphere, land are from the Climate Forecast System Reanalysis (CFSR)
- Real-time forecast products are calibrated based on the hindcasts climatology

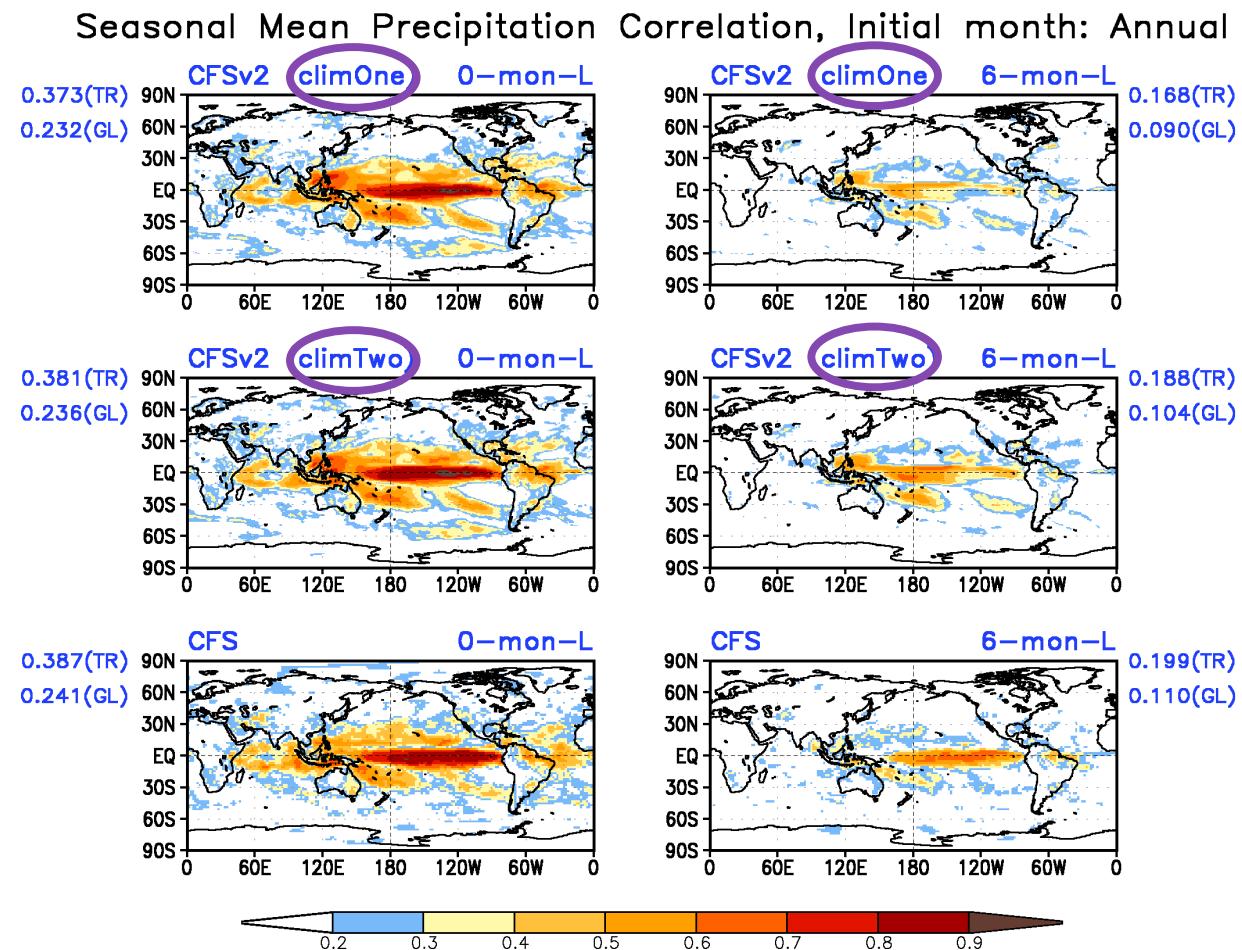
CFSv2 Hindcasts : Seasonal

- Period : 1982 - 2010
- 4 runs/day; every 5th day
- Hindcasts are used for
 - *Lead time dependent climatology*
 - *Calibration (mean; standard deviation)*
 - *Skill assessments and skill masks*

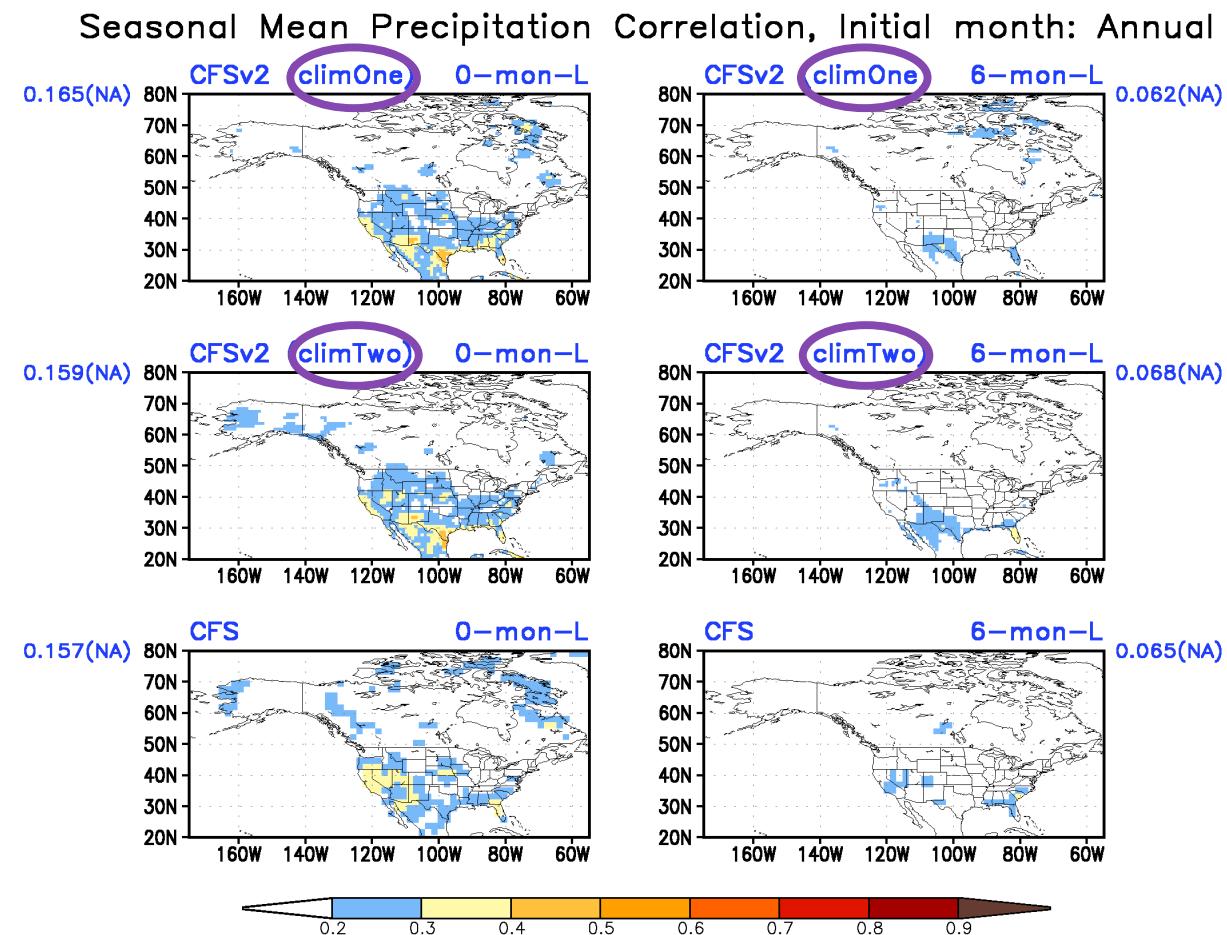
CFSv2 Hindcasts : Monthly

- Period : 1999- 2010
- 4 runs/day; 45 day
- Hindcasts are used for
 - *Calibration (mean; standard deviation)*
 - *Skill assessments and skill masks*

Anomaly Correlation – Precipitation



Anomaly Correlation – Precipitation



An Example for CFSv1

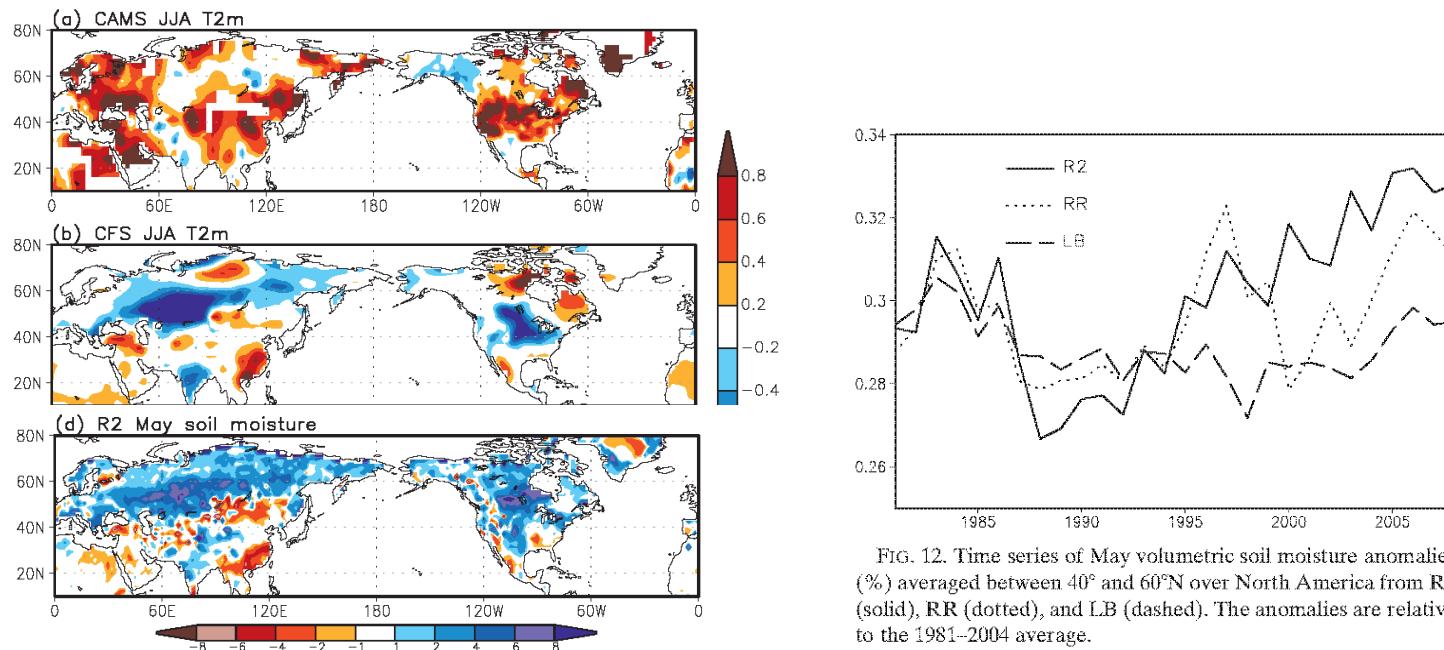


FIG. 12. Time series of May volumetric soil moisture anomalies (%) averaged between 40° and 60°N over North America from R2 (solid), RR (dotted), and LB (dashed). The anomalies are relative to the 1981–2004 average.

Anomaly Correlation – Sfc. Temp.

